MULTIMEDIA UNIVERSITY

STUDENT IDENTIFICATION NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

BOP2024 – PRINCIPLES OF OPERATION RESEARCH

(All Section/Group)

08 March 2017
9.00am – 11.00am
(2 Hours)

INSTRUCTION TO STUDENT

1. This question paper consists of **SIX (6)** pages including cover page with **FOUR (4)** questions only.
2. Attempt **ALL** the questions.
3. Please write all your answers in the Answer Booklet and Graph Papers provided.
4. The distribution of the marks for each question is given. Total marks 100.

QUESTION 1 (25 marks)

a) Solve the following linear program by the graphical method. Label the graph appropriately.

Max $4X + 5Y$

s.t. $X + 3Y \leq 22$
$-X + Y \leq 4$
$Y \leq 6$
$2X - 5Y \leq 0$
$X, Y \geq 0$

(13 marks)

b) An automated teller machine, ATM is to be located in a campus building to minimize the distance from the food court, the gift shop, and the theatre. They are located at coordinates (2,2), (0,6) and (8,0). Develop a Goal Programming model to locate the best spot for the ATM.

(12 marks)

QUESTION 2 (25 marks)

a) The LINDO output for the linear programming model in **Table 1** represent a problem whose solution will tell a specialty retailer how many of four different styles of umbrellas to stock in order to maximize profit. It is assumed that all stocked umbrellas will be sold. The variables, X1, X2, X3, X4 measure the number of women's, golf, men's and folding umbrellas, respectively. The constraints are listed as 2) storage space in units, 3) special display racks, 4) demand and 5) a marketing restriction, respectively.

MAX $4X1 + 6X2 + 5X3 + 3.5X4$

SUBJECT TO

2) $X1 + 3X2 + 3X3 + X4 \leq 120$

3) $1.5X1 + 2X2 \leq 54$

4) $2X2 + X3 + X4 \leq 72$

5) $X2 + X3 \geq 12$

END

Continued...

Table 1: LINDO Output

OBJECTIVE FUNCTION VALUE

1) 318.00000

		RIGHTHAND SIDE RANGES	
ROW	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	120.000000	48.000000	24.000000
3	54.000000	INFINITY	36.000000
4	72.000000	24.000000	48.000000
5	12.000000	12.000000	12.000000

VARIABLE	VALUE	REDUCED COST
X1	12.000000	.000000
X2	.000000	.500000
X3	12.000000	.000000
X4	60.000000	.000000

ROW	SLACK OR SURPLUS	DUAL PRICE
2)	.000000	2.000000
3)	36.000000	.000000
4)	.000000	1.500000
5)	.000000	−2.500000

RANGES IN WHICH THE BASIS IS UNCHANGED:

		OBJ. COEFFICIENT RANGES	
VARIABLE	CURRENT COEFFICIENT	ALLOWABLE INCREASE	ALLOWABLE DECREASE
X1	4.000000	1.000000	2.500000
X2	6.000000	.500000	INFINITY
X3	5.000000	2.500000	.500000
X4	3.500000	INFINITY	.500000

Use the LINDO output in **Table 1** to answer the following questions.

i) How many women's umbrellas should be stocked? (1 mark)
ii) How many golf umbrellas should be stocked? (1 mark)
iii) How many men's umbrellas should be stocked? (1 mark)
iv) How many folding umbrellas should be stocked? (1 mark)
v) How much space is left unused? (1 mark)
vi) How many racks are used? (1 mark)

Continued...

vii) By how much is the marketing restriction exceeded? (1 mark)
viii) What is the total profit? (1 mark)
ix) By how much can the profit on women's umbrellas increase before the solution would change? (2 marks)
x) To what value can the profit on golf umbrellas increase before the solution would change? (2 marks)
xi) By how much can the amount of space increase before there is a change in the dual price? (2 marks)
xii) You are offered an advertisement that should increase the demand constraint from 72 to 86 for a total cost of $20. Would you say yes or no? (2 marks)

b) Richardson Harris is interested in purchasing a new Harley-Davidson motorcycle. He has narrowed his choice to one of three models: Sportster Classic, Heritage Soft tail and Electra Glide. After much consideration, Richardson has determined his decision-making criteria, assigned a weight to each criterion, and rated how well each decision alternative satisfies each criterion in **Table 2** below.

Table 2: Decision Alternative

Criterion	Weight	Sportster Classic	Heritage Softtail	Electra Glide
Wind protection	5	3	6	8
Fuel tank capacity	3	5	7	6
Passenger comfort	2	5	6	8
Seat height	3	8	5	6
Acceleration	4	8	5	3
Vehicle weight	3	8	6	3
Storage capacity	3	4	5	8

Use a scoring model to determine the recommended motorcycle model for Richardson. (9 marks)

Continued...

QUESTION 3 (25 marks)

a) Relax Plus Inc. (RPI) manufactures a standard dining chair used in restaurants. The demand forecasts for quarter 1 (January-March) and quarter 2 (April-June) are 3700 chairs and 4200 chairs, respectively. RPI has a policy of satisfying all demand in the quarter in which it occurs. The chair contains an upholstered seat that can be produced by RPI or purchased from BAP, a subcontractor. BAP currently charges \$12.50 per seat, but has announced a new price of \$13.75 effective April 1. RPI can produce the seat at a cost of \$10.25. RPI can produce up to 3800 seats per quarter. Seats that are produced or purchased in quarter 1 and used to satisfy demand in quarter 2 cost RPI \$1.50 each to hold in inventory, but maximum inventory cannot exceed 300 seats.

Formulate this problem as a linear programming problem.

(12 marks)

b) Consider a capital budgeting problem of a selection of five projects. Let $x_i = 1$ if project i is selected, 0 if not, for i = 1,...,5. Write the appropriate constraint(s) for each condition. Each condition is independent from the other.

i) Choose no fewer than three projects.
ii) If project 3 is chosen, project 4 must be chosen.
iii) If project 1 is chosen, project 5 must not be chosen.
iv) Projects cost 100, 200, 150, 75, and 300 respectively. The budget is 450.
v) No more than two of projects 1, 2, and 3 can be chosen.

(13 marks)

QUESTION 4 (25 marks)

a) RVW (Restored Volkswagens) buys 15 used VW's at each of two car auctions each week held at different locations. It then transports the cars to repair shops it contracts with. When they are restored to RVW's specifications, RVW sells 10 each to three different used car lots. There are various costs associated with the average purchase and transportation prices from each auction to each repair shop. Also there are transportation costs from the repair shops to the used car lots. RVW is concerned with minimizing its total cost given the costs in the table below.

Given the costs in **Table 3** below, draw a network representation diagram for this problem. Label the diagram appropriately.

Table 3: Cost for Restored Volkswagen (RVW)

	Repair Shops	
	S1	S2
Auction 1	550	500
Auction 2	600	450

	Used Car Lots		
	L1	L2	L3
S1	250	300	500
S2	350	650	450

(11 marks)

Continued...

b) Given the following simplex tableau in **Table 4**.

Table 4: Simplex Tableau

		x_1	x_2	x_3	s_1	s_2	s_3	
Basis	c_B	5	8	12	0	0	0	
s_1	0	3	4	5	1	0	0	80
s_2	0	9	15	20	0	1	0	250
s_3	0	1	−1	2	0	0	0	20
	z_j	0	0	0	0	0	0	0
	$c_j - z_j$	5	8	12	0	0	0	

i) What variables form the basis? (3 marks)

ii) What are the current values of the decision variables? (3 marks)

iii) What is the current value of the objective function? (1 mark)

iv) Which variable will be made positive next and what will its value be? (3 marks)

v) Which variable that is currently positive will become 0? (2 marks)

vi) What value will the objective function have next? (2 marks)

End of Paper